# PIChE National Quiz Bowl

## Part 2

# 10 sec; Multiple choice

Although energy assumes many forms, the total quantity of energy is constant, and when energy disappears in one form it appears simultaneously in other forms.

**A) First law of thermodynamics**

B) Second Law of thermodynamics

C) Third Law of Thermodynamics

D) Law of mass action

# 2 min. PS

Water flows over a waterfall 100 m in height. Take 1 kg of the water as the system, and assume that it does not exchange energy with its surroundings. After the 1 kg water enters the river below the falls, what change has occurred in its temperature?

Ans. $0.23^{o}C$

# 10 sec. MC

How many degrees of freedom has the system of liquid water in equilibrium with a mixture of water vapor and nitrogen?

a) 1

**b) 2**

c) 3

d) 4

# 2 min. PS

A horizontal piston/cylinder arrangement is placed in a constant-temperature bath. The piston slides in the cylinder with negligible friction, and an external force holds it in place against an initial gas pressure of 14 bar. The initial gas volume is 0.03 $m^3$ . The external force on the piston is reduced gradually, and the gas expands isothermally as its volume doubles. If the volume of the gas is released to its pressure so that the product $PV^t$ is constant, what is the work done by the gas in moving the external force?

Ans. – 29,112 J

Calculate $\Delta U$ for 1 kg of water when it is vaporized at the constant temperature of 100°C and the constant pressure of 101.33 kPa . The specific volumes of liquid and vapor water at these conditions are 0.00104 and 1.673 $m^3 kg^{-1}$ . For this change, heat in the amount of 2,256.9 kJ is added to the water.

Ans. 2,087.50 kJ

# 2 min. PS

Calculate the internal-energy that occur when air is changed from initial state of 40°F and 10 atm, where its molar volume is 36.49 $ft^3$ / lbmole, to a final state of 140°F and 1 atm. Assume for air that PV/T is constant and that Cv= 5 and Cp= 7 Btu/lbmole. °F.

Ans. 507.7 Btu

# 2 min. PS

Air at 1 bar and 25oC enters a compressor at low velocity, discharges at 3 bar, and enters nozzle in which it expands to a final velocity of 600m/s at the initial conditions of pressure and temperature. If the work of compression is 240 kJ per kg of air, how much heat must be removed during compression?

Ans. – 60kJ/kg

# 2 min. PS

For liquid acetone at 20oC and 1 bar,

$\beta = 1.487 \times 10^{-3}\ {}^{o}C^{-1}$

$\kappa = 62 \times 10^{-6}$/ bar

V= 1.287 cm$^3$/g

Calculate the pressure generated by heating at constant V from 20oC and 1 bar to 30oC.

Ans. 241 bar

# 2 min. PS

Air is compressed from an initial condition of a 1 bar and 25oC to a final state of 5 bar and 25oC by adiabatic compression followed by cooling at constant volume. Assume air to by an ideal gas with the constant heat capacities, Cv = (5/2)R and Cp= (7/2) . Calculate the work required.

Ans. 5,600 J

# 2 min. PS

Air is compressed from an initial condition of 1 bar and 25$^o$C to a final state of 5 bar and 25$^o$C by isothermal compression.

Ans. 3,990 J

# 15 sec. ID

A theorem that states,

The thermal efficiency of a Carnot engine depends only on the temperature levels and not upon the working substance of the engine.

Ans. CARNOT’S THEOREM

# 10 sec. MC

The Law that states, the total entropy change associated with any process must be positive, with a limiting value of zero

for a reversible process.

A) First law of thermodynamics

**B) Second Law of thermodynamics**
C) Third Law of Thermodynamics

D) Law of mass action

# 15 sec. ID

For any closed system formed initially from given masses of prescribed chemical species, the equilibrium state is completely determined when any two independent variables are fixed.

Ans. DUHEM’S THEOREM

# 15 sec. ID

A measure of the energy in a system or process that is unavailable to do work.

Ans. ENTROPY

# 15 sec. ID

A partial molar property(other than volume) of a constituent species in an ideal gas mixture is equal to the corresponding molar property of the species as a pure ideal gas at the mixture temperature but at a pressure equal to its partial pressure in the mixture

Ans. GIBB’S THEOREM

# 15 sec. ID

The process of coating the surface of a substance rather than being absorbed by it, accompanied by chemical bonding between the surface of the material and the adsorbed substance

Ans . CHEMISORPTION

The product of oxidation of

Ethylbenzene with aqueous $KMnO^4$.
Ans. BENZOIC ACID

# 15 sec. ID

What is the immediate precursor in the preparation of m-Chloronitrobenzen?

**A) Chlorination of Nitrobenzene**

B) Nitration of Chlorobenzene

C) Nitration of benzene

D) Chlorination of benzene

# ( 2 min) Stoichiometry

Pure ethane is burned completely in 20% x's air. Air is supplied at 25$^{O}$C, 740 torr

and is substantially dry. Calculate the Orsat Analysis of the products of combustion.

- $CO_2$ = 10.81%
- $O_2$ = 3.78%
- $N_2$ = 85.41%

# ( 10 seconds)  Stoichiometry

Hydrogen in the fuel that uses $O_2$ from air for combustion. Equals to the total hydrogen in the fuel if no $O_2$ is present in the fuel.

NET HYDROGEN

# (10 SEC )

Common name for a mixture of $SO_3$ and $H_2SO_{4.}$

OLEUM

# ( 10 sec )

A process which involves the catalytic oxidation of $SO_2$ to $SO_3$ using Vanadium Pentoxide or Platinum dispersed in asbestos or silica gel catalyst under appropriate conditions in a converter.

CONTACT PROCESS

# ( 2 min )

A 1.200 g sample of a mixture of NaOH and $Na_2CO_3$ with inert impurity is dissolved and titrated cold with 0.5000 N HCl. With phenolphthalein as the indicator, the solution turns colorless after the addition of 30.00 mL of the acid. Methyl orange is then added, and 5.00 mL more of the acid are required for the color to change to pink. What is the percentage of NaOH in the sample?

41.67%

# 2 min

What is the Normality of KMnO4 solution if 40.00 mL will oxidize 0.3000 g of $Na_2C_2O_4$?

0.11 N

# ( 2 min )

A sample of feldspar gives the following analysis:

$K_2O$= 19.90%      MW= 94.19

$Al^2O^3$= 18.28%      MW= 101.9
$SiO_2$= 64.74%      MW= 60.06

What is the empirical formula of feldspar?
$KAlSi_3O_8$

# 2 min

A sample of magnetite ( impure $Fe_3O_4$) weighing 0.5000 g is fused with an oxidizing flux and the ferric compound so formed is eventually pptd as ferric hydroxide and ignited to ferric oxide. The weight of the latter is found to be 0.4980 g. What is the percentage of iron in the magnetite in terms of $Fe^3O^4$?
96.27%

# 5 sec

Gives Emerald green in flame test

A) Calcium

B) Strontium

**C) Copper**

D) Potassium

# 5 sec

Gives red color in flame test

**A)Calcium**

B) Strontium

C) Copper

D) Potassium

# 5 sec

Gives crimson color in flame test

A)Calcium

B) **Strontium**

C) Copper

D) Potassium

# 5 sec

Gives pale blue color in flame test

A)Calcium

B) Strontium

**C) Arsenic**

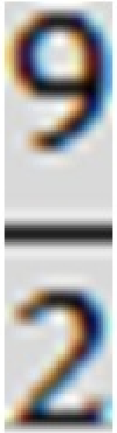
D) Potassium

A and B working together can finish the job in 3 days, B and C together can finish the same job in 4 days, and A and C in 2.5 days. In how many days can all of them finish the job working together?

Ans. 2.03 days

Find the area bounded by the curve $x = y^2 - 1$ and the line

$y = x - 1$



$\frac{9}{2}$

One half of a kg of liquid water at 273 K is placed outside on a day when the temperature is 261 K. Assume that the heat is lost from water only by means of radiation and the emissivity of the radiating surface is 0.60. How long ( in hours ) does it take for the water to freeze into ice at 0 ℃ if the surface area from which the radiation occurs is 0.035 $m^2$ ?

Latent heat of fusion for water is 3,350,000 J/kg

( Stefan-Boltzmann constant) $\sigma = 5.67 \times 10^{-8} J/(s.m^2.K^4)$

Answer: 42 h

Find the waste in making the largest possible cylindrical rod from a bar of iron 3 ft. long which has a square cross-section whose diagonal is 6 inches.

Answer : 139.06 cu.in.

What do you call a polygon of 100 sides?

Answer: HECTAGON

The base edge of a regular hexagonal prism is 6 cm and its bases are 12 cm apart. Find its volume in cu.cm.

Answer: 1122.37 cu.cm.

A gymnast on a high bar swings in clockwise direction through two revolutions in a time of 1.27 seconds.

Find the average angular velocity in rad/s .

Answer: - 9.89 rad/sec

A point at which a body may be supported in any position with no tendency to turn.

Answer: CENTER OF GRAVITY

How many grams of gold must be added with 500 grams of an alloy containing 30% gold and 70% silver in order to produce another alloy analyzing 40% gold and 60% silver?

Answer: 83.33 grams

A tank contains initially 2,500 liters of 50% salt solution. Water enters the tank at the rate of 25 liters per minute and the solution flows out at the rate of 50 liters per minute. Find the percentage of salt after 20 minutes.

Answer: 40%

Cyanogen, a highly toxic gas, is composed of 46.2%C and 53.8%N by mass. AT 25°C and 750 torr, 1.05g of cyanogen occupies 0.5 L. Find the molecular formula of cyanogen.

ANSWER: $C_2N_2$

A mixture of Argon (atomic mass = 39.95) and Nitrogen (atomic mass = 14) has a density of 1.413 g/L at STP. What is the mol fraction of Argon in this mixture?

ANSWER: 0.31

Water is flowing into a conical tank 15 cm deep and having a radius of 3.75 cm across the top. If the rate at which the water rises is 2 cm/sec, how fast is the water flowing into the conical tank when the water is 4 cm deep?

Ans. 6.28 m$^3$/sec

Water is pouring into a swimming pool. After **$t$** hours there are **$t + \sqrt{t}$** gallons in the pool. At what rate is the water pouring into the pool when $t = 9$ hours ?

Ans. 7/6 gph

Find the Laplace transform of $f(t) = t^2$

Ans. $2/s^3$

# Find the Laplace of $f(t) = 3 - 2t + 4t^2$

Ans. $3/s - 2/s^2 + 8/s^3$

What is the percent dissociation of 0.2 M Acetic Acid? Ka= $1.8 \times 10^{-5}$

Ans. 0.95%

Series of equal payments occurring at equal interval of time.

Ans. Annuity

The reduction of fall in the value of an asset or physical property during the course of its working life and due to the passage time.

Ans. DEPRECIATION

A man purchased on monthly installment a P100,000 worth of land.

The interest rate is 12% nominal and payable in 20 years. What is the monthly amortization?

Ans. P 1,101.08

A person buys a piece of lot for P100,000 down payment and 10 deferred semiannual payments of P8,000 each, starting three years from now. What is the present value of the investment it the rate of interest is 12% compounded semiannually?

Ans. P143,999.08

An equipment costs P10,000 with a salvage value of P500 at the end of 10 years. Calculate the annual depreciation cost by sinking fund method at 4%.

Ans. P791.26

To 50 mL of $H_2CO_3$ solution is added 25 mL of 0.0500 N $Ba(OH)_2$. 13.25 mL 0f 0.0510 N HCl is required to titrate to the phenolphthalein end point. What is the molarity of the $H_2CO_3$ ?

Ans. 0.00574 M

If 1.000 g of a mixture of AgCl and AgBr weighs 0.6635 g of Ag, what is the percentage of bromine?

Ans. 21. 30%

A sample containing NaCl, NaBr and inert material weighs 1.000 g; with excess $AgNO_3$ it gives ppt consisting of AgCl and AgBr which weighs 0.5260 g. By heating this ppt. in a current of chlorine gas, The AgBr is converted to AgCl, and the ppt. then weighs 0.4260. What is the percentage of NaCl in the original sample?

Ans. 4.25%